# THE EFFECTS OF INCREASED COGNITIVE LOAD, SOCIABILITY AND FAMILY HISTORY OF SUBSTANCE USE ON DELAY DISCOUNTING

By

THEODORE L. WAGENER

Bachelor of Arts in Psychology

College of Wooster

Wooster, Ohio

2002

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
December, 2005

THE EFFECTS OF INCREASED COGNITIVE LOAD,

SOCIABILITY AND FAMILY HISTORY

OF SUBSTANCE USE ON

DELAY DISCOUNTING

Thesis Approved:

Frank Collins Ph.D.
Thesis Adviser

Thad Leffingwell Ph.D.

Jennifer Callahan Ph.D.

A. Gordon Emslie
Dean of the Graduate College

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure Page

# CHAPTER I

## INTRODUCTION

Delay discounting is a concept that has developed in behavioral economic research during the past few decades. It has typically been viewed as a behavioral measure of impulsivity and specifically measures individual choice as a function of choosing a smaller, immediate reward or a larger, delayed reward. Research in this area has indicated that substance abusers discount delayed rewards at a much higher rate than non-substance abusers (e.g., Petry, 2001; Richards, Zhang, Mitchell & de Witt, 1999; Vuchinich & Simpson, 1998). Thus far, the cause of this difference has been unclear. Correlational research has pointed to such variables as impulsivity (e.g., Vuchinich & Simpson, 1998), introversion-extroversion (Ostaszewski, 1996, 1997), level of sociability (Collins, Vincent, Sorraco, & Lovallo, 2005) and cognitive factors such as executive functioning (Barkley et al., 2001) and working memory (Hinson et al., 2003).

Previous research regarding family history of substance use has shown that children whose parents have substance use disorders are more likely than controls to develop substance use problems of their own (Cloninger, Bohman & Sigvardssou, 1981; Cotton, 1979; Kapiro et al., 1987). However, when researchers have accounted for the children's level of sociability (So) as well as family history of substance use, they have found that children who have high sociability do not seem to be affected the same as

children with low sociability (Werner, 1986). Specifically, children who were higher in sociability and had a family history of substance use disorder (FH+) were relatively free of personal problems, while the children who were low in sociability were not. The consequence of this finding may be that sociability is more strongly associated with future substance abuse and delay discounting than is family history. Recently, this hypothesis was supported in research conducted by Collins et al. (2005).

Collins et al. (2005) conducted a study of 192 non-drug-dependent young adults in an attempt to assess possible differences in delay discounting as a function of family history (FH) and sociability. The results of the study suggest that FH alone is not significantly related to delay discounting, but sociability was significantly related to discounting.

In addition to the above developments, Hinson, Jameson and Whitney (2003) demonstrated that delay discounting is modifiable. By adding a third choice to a delay discounting task, and thereby increasing cognitive load, participants discounted delayed rewards at a higher rate than when there were only two choices. That is, the study suggests that delay discounting may be affected by increased cognitive burden.

As a result of these developments in the literature, the present study will attempt to define a relationship between sociability, family history of substance abuse, increased cognitive load and delay discounting. Furthermore, we will attempt to replicate the Collins et al. (2005) study and try to determine whether sociability is more strongly related to discounting than is a positive family history of a substance use disorder. Finally, we will investigate whether individuals who differ with regard to level of

sociability are differentially affected by increased cognitive burden by adding a three-choice delay discounting task.

Delay discounting research may have important practical implications in the assessment and treatment of substance use disorders. Specifically, since groups of individuals with substance use disorders discount delayed rewards more steeply than controls, it may be possible that assessment based on behavioral discounting measures may be able to predict who is at risk and who is most likely to benefit from interventions. Additionally, delay discounting may possibly be used to assess if substance abuse treatment worked. That is, previous research has shown that ex-smokers discount delayed rewards in a fashion that is similar to matched, never-before smokers (Bickel et al., 1999). This evidence may indicate that discounting might be related to the effects of abstinence. Although the evidence is encouraging and the possibilities of delay discounting research are exciting, much more research is needed in this area.

# CHAPTER II

# LITERATURE REVIEW

The following sections will provide a review of the delay discounting literature, further explanation of the goals and hypotheses of the present study, along with a detailed description of the proposed studies procedure of measurement and a method to analyze those measures.

## *Delay Discounting*

The degree to which the value of a reinforcer is influenced by time delay is known as delay discounting (Ainslie, 1992; Myerson & Green, 1996). The prototypical example of delay discounting is when an individual must choose between a smaller reward available sooner and a larger reward available later. A real world illustration of this type of choice is when an individual decides to either use heroin and receive the immediate reward of the drug's effect, or to not use and receive the larger reward of reducing harmful behavior that could lead to future problems (e.g., familial, social, academic, health).

Delay discounting research has demonstrated that, when adding the dimension of time delay to reward size in choice task, a preference reversal occurs (Bickel & Madden, 1999; Green et al., 1981; Green, Fristoe, & Myerson, 1994; Green et al., 1997; Kirby & Herrnstein, 1995; Loewenstein & Elster, 1992; Mazur, 1987). The preference reversal phenomenon is when an individual reverses their decision from a large, delayed reward to a smaller, immediate reward. More specifically, an individual chooses the larger reward

available later when both that reward and the more immediate, smaller reward are available far into the future; however, with the passage of time the preference becomes reversed and the individual chooses the more immediate, smaller reward (Green & Myerson, 2004; Green, Myerson, & McFadden 1997). For example, an individual may prefer to receive $500 immediately as opposed to $550 dollars in 2 months, however, when asked if they would prefer $500 in one year or $550 in 1 year and 2 months, individuals may be more inclined to choose the larger, later reward. Preference reversals, according to discounting theory, occur because over time the subjective value of the smaller, more immediate reward increases more quickly than the subjective value of the larger, later reward when there is an equivalent decrease in the delays associated with each of the two rewards (Green & Myerson, 2004). Taken from another point of view, preference reversals occur due to the subjective value of the larger, later reward decreasing more slowly when its acquisition is more delayed, as compared to the subjective value of the smaller, more immediate reward.

This preference-reversal phenomenon has provided insight into the development of a discounting function. This function is hyperbolic and attempts to relate the subjective value of the reward to the time it is received (Green, Fristoe, & Myerson, 1994). This hyperbolic function is expressed in the following equation (Mazur, 1987):

$$V = A/(1 + kD)$$

Where $V$ is the subjective value of the delayed reward, $A$ is the amount of the delayed reward, $D$ is the delay to its receipt, and $k$ is the parameter that governs the rate at which the value declines with time. Collins et al. (2005) explain that $k$ is best conceptualized as an indifference point where the individual finds the immediate value equal to the delay

value. Smaller values of *k* are indicative of slower rates of discounting, while larger values of *k* represent faster rates of discounting. Thus, individuals with large values of *k* quickly devalue delayed rewards and have a very small immediate indifference point (Collins et al., 2005). The hyperbolic function has been demonstrated in many empirical studies (e.g., Ainsle, 1992; Kirby, 1997; Kirby & Marakovic, 1995; Kirby & Santiesteban, 2003; Green, Myerson, & McFadden, 1997; Mazur, 1987; Rachlin et al., 1991; Raineri & Rachlin, 1993; Simpson & Vuchinich, 2000).

The rate at which an individual discounts an outcome (i.e., the *k* value) can be determined by using methods of psychophysical scaling (Baker, Johnson, & Bickel, 2003). During this procedure, an individual is presented with a fixed outcome option and an immediate outcome option that is adjusted until the individual finds the two options equivalent in value. For example, an individual may be presented with a choice between $150 paid after three months and smaller amount of money paid today (e.g.,$10). The magnitude of the immediate reward is then adjusted from $10 until the individual reaches a point of indifference between the two options (e.g., indifferent between $150 in three months and $100 today). The individuals then estimate the value of the $150 paid after other delays as well (e.g., six months, one year, or ten years). Finally, the rate which the value of the $150 is delay discounted is estimated by fitting hyperbolic function to the indifference points obtained for each of the delays (Baker, Johnson, & Bickel, 2003).

*Factors that Influence Delay Discounting*

Two types of factors influence delay discounting. First, there are factors that deal with the particular reward itself (Level I Factors), such as the domain of the reward, the sign of the reward (receipt of outcomes that constitute a gain versus a loss), the

magnitude of the reward, and the length of delay preceding receipt of the reward. Secondly, there are factors that involve the individual themselves (Level II Factors), such as the age of the individual, their income, culture, personality traits, abuse or non-abuse of a substance, and executive functioning. All of these factors have been tested against delay discounting in order to see what influences they may have. Typically, Level I Factors are studied while varying individuals Level II Factors (e.g., Madden, Bickel & Jacobs, 1999; Madden et al., 1997; Odum, Madden, Badger & Bickel, 2000). This cross-comparison of factors will follow after a brief explanation of each factor and how it can solely influence delay discounting.

*Level I Factors*. Baker, Johnson, and Bickel (2003) describe that the domain effect refers to the rate at which a reward is discounted depends on the commodity being considered. Early research studying the domain effect first compared discounting rates for hypothetical monetary gains, vacations, and health gains (Chapman & Johnson, 1995). Researchers found that health gains are typically discounted at a higher rate than vacations and monetary gains and that monetary gains and vacations did not differ in their delay discount rate. However, Chapman and Johnson's (1995) research does not take into account the sign effect, which is another factor that has an effect on delay discounting.

The sign effect refers to the observation that outcomes that constitute a gain are delay discounted at a higher rate than outcomes that constitute a loss (Baker, Johnson & Bickel, 2003). For example, Cairns (1992) found that individuals will discount hypothetical monetary losses at a higher rate than hypothetical health losses. This result demonstrates the sign effect, whereby changing the sign of the reward will change the

rate of discounting of that reward. That is, individuals who typically value monetary gains over health gains switch to valuing their health more than money when incurring a loss. Studies have also found that individuals tend to discount hypothetical money gains at a steeper rate than hypothetical money losses and discount health gains at a steeper rate than health losses (Baker, Johnson & Bickel, 2003; Benzion, Rapoport & Yagil, 1989; Loewenstein, 1988; Shelley, 1993; Thaler, 1981; for health discounting, Chapman, 1996; MacKeigan et al., 1993).

In addition to the domain and sign effect, delay discounting is also influenced by what is called the magnitude effect. This effect refers to the finding that individuals will discount smaller delayed gains at a higher rate than larger delayed gains, or taken from another point of view, individuals will typically discount smaller delayed losses at a higher rate than larger delayed losses. For example, an individual will typically choose a $500,000 reward available in one year as opposed to a $100,000 reward available now and choose a $5 reward now over $25 in one year. Although the proportion of the two rewards for the two scenarios are equal, individuals will typically discount the larger reward less when it becomes too large to not choose it. The magnitude effect has been demonstrated in numerous studies regarding hypothetical and real monetary rewards (Benzion, Rapoport & Yagil, 1989; Green, Fristoe & Myerson, 1994; Green, Fry & Myerson, 1994; Green, Myerson, & McFadden, 1997; Johnson & Bickel, 2002; Kirby, 1997; Kirby & Markovic, 1996; Myerson & Green, 1995; Raineri & Rachlin, 1993; Thaler, 1981). Furthermore, it has been shown to hold up in regards to vacations and hypothetical health outcomes (Chapman, 1996; Chapman & Johnson, 1995; Raineri & Rachlin, 1993). It should further be noted that Green, Myerson and McFadden (1997), in

an attempt to replicate the magnitude effect in a delay discounting paradigm, found that the discounting rate decreased in a "negatively accelerated fashion" as the amount of the delayed, hypothetical monetary reward increased from $100 to $25,000. A leveling effect, however, was also produced when the reward increased beyond $25,000, up to $100,000.

The length of delay until the receipt of the reward has also been shown to influence delay discounting (Green, Fristoe, & Myerson, 1994; Green, Myerson, & McFadden, 1997; Ostaszewski, 1996; Richards, Zhang, Mitchell & deWitt, 1999; Vuchinich & Simpson, 1998). Typically, the longer the delay to the reward the steeper it will be discounted. It can be inferred from Vuchinich and Simpson's (1998) study that a reward that is delayed for 300 months (25 years) reduces in its subjective value by 50% to 90%. The influence of length of delay is illustrated in the state lottery, that is, typically, individuals choose to take the smaller, immediate sum of money instead of the larger sum of money spread out over 30 years.

In sum, the domain effect, the sign effect, the magnitude effect, and the length of delay are all types of level one factors that influence delay discounting, and, therefore, should be controlled so as to not provide a confound in discounting research.

*Level II Factors*. The first individual factor that has demonstrated influence on delay discounting is the age of the individual. Mischel, Shoda and Rodriguez (1989) reported that with an increase in age came an increase in the ability to delay gratification. Therefore, discounting researchers hypothesized that if this ability to delay gratification increases throughout the life span, then older adults would be expected to discount delayed rewards at a lower rate than children or young adults (Green, Fry & Myerson,

1994). Green, Fry and Myerson (1994) also hypothesized that it could be possible that with increasing age individuals may have a fear of not surviving until the receipt of the delayed reward, and, therefore, this could lead to greater delay discounting rates in older adults. The results of the study showed that older individuals discounted delayed rewards at a slower rate than younger individuals.

In a follow-up, Green et al. (1996) examined income and its influence on delay discounting of older adults and younger adults. The study looked at a higher socioeconomic status (SES), younger adult group ($M_{age}$ = 33.3 years; $M_{income}$ = $50,000 per year), a higher SES, older adult group ($M_{age}$ = 70.7 years; $M_{income}$ = $50,000 per year) and a lower SES, older adult group ($M_{age}$ = 70.8 years; $M_{income}$= $10,000 per year). The results of the study showed that adults of different ages, but of similar SES levels, tended to discount delayed rewards at a similar rate; however, individuals of similar age and different SES levels tend to discount delayed rewards differently. Specifically, SES and rate of discounting appear to be inversely related. Green et al. (1996) seems to contrast their earlier study (Green, Fry, & Myerson, 1994) which showed the rate of delayed discounting systematically decreased from childhood to old age. The researchers suggest that income may be a more important variable than age in decision making.

Furthermore, Green et al. (1996) research uncovered an interesting effect of income on delay discounting. The reason that it is interesting is that one might assume that the subjective value of the same monetary amount would be greater for a poorer person as opposed to a richer person. Furthermore, given that larger delayed amounts are discounted less steeply than smaller amounts (i.e. the magnitude effect), it should follow that the poorer person would discount the delayed monetary reward less steeply.

However, Green et al. (1996) results propose that this is not the case, that the opposite will occur, even when the level of education is held similar across groups (Green & Myerson, 2004).

The third individual factor has been demonstrated to influence delay discounting is the culture of the individual making the choice. In the seminal research conducted by Du, Green and Myerson (2002), researchers found that among American, Chinese and Japanese individuals, American and Chinese individuals discounted the delayed reward at a steeper rate than the Japanese. Furthermore, since all three groups discounting data fit the hyperbolic line the best, it suggests that individuals are qualitatively similar cross-culturally in how they discount.

In addition to age, income, and culture influencing delay discounting behavior, there has been a recent accumulation of research demonstrating that substance abusers typically delay discount at a higher rate than non-abusers. Individuals included under the title of substance abusers include alcoholics, heavy social drinkers, cigarette smokers, opiod-dependent individuals, and marijuana and cocaine users. Research has also demonstrated that compulsive gamblers discount delayed rewards at a higher rate than non-gamblers. Typically there is a high rate of substance abuse in this group. Petry and Casarella (1999) reported that not only did substance abusing individuals delay discount at a higher rate than non-substance abusing controls, but also that substance abusing problem gamblers discount delayed rewards at an even faster rate than non-gambling substance abusers. Green and Myerson (2004) point to the possibility that there is likely to be an additive effect with regard to group membership and delay discounting. That is,

the more comorbid addictive behaviors an individual demonstrates, the more likely they are to discount delayed rewards at a steeper rate.

Several studies have pointed to a relationship between higher rates of discounting and cigarette smokers (Baker, Johnson & Bickel, 2003; Bickel, Odum & Madden, 1999; Mitchell, 1999; Reynolds, Richards, Horn & Karraker, 2004). One interpretation of this finding is that individuals who are more likely to discount delayed rewards (health) and choose the immediate reward (satisfaction of smoking), may be more prone to choose the activity of smoking, where this type of discounting occurs daily. It could also be the case that cigarette smoking itself could lead to these increased discounting rates, not that individuals who choose smoking tend to be steeper "discounters" *a priori*. The only evidence that suggests cigarette smoking leads to increased discounting rates is that ex-smokers discount in a fashion similar to matched non-smokers (Bickel et al., 1999). Myerson and Green (2004) point out that it is important to keep in mind that although group-specific experiences may be a cause of group differences in delay discounting, it is also quite possible that individual differences in discounting help to determine group membership (i.e. being a substance abuser).

In addition to the comparison of discounting in smokers and gamblers, researchers have reported that alcoholics/heavy drinkers (Petry, 2001; Richards, Zhang, Mitchell & de Witt, 1999; Vuchinich & Simpson, 1998) and opiod-dependent individuals (Kirby, Petry & Bickel, 1999; Madden, Petry, Badger & Bickel, 1997) delay discount at steeper rates than non-substance-abusing controls. Furthermore, Petry (2001) reported that alcoholics discounted hypothetical alcohol rewards, of equal monetary value, at a faster rate than hypothetical monetary rewards. Likewise, Madden, Petry, Badger & Bickel

(1997) found the same effect, with regard to hypothetical heroine rewards and hypothetical monetary rewards. It was also reported that individuals who discounted hypothetical money rewards at a steeper rate tended to discount heroine rewards at a steeper rate. Green and Myerson (2004) make an important point regarding this effect of abused substances being discounted more steeply than money when they state:

> "Not only may substance abusers differ from non-abusers in terms of discounting, but in addition, those who tend to show less self-control may, as a result, engage in behavior involving rewards that, by their nature, tend to undermine self-control, thereby exacerbating the problem." (p. 784)

Ostaszewski (1996) investigated a fifth factor, personality traits. The study attempted to determine whether there is a relation between the rate of delay discounting and temperament, specifically, sensation seeking, introversion-extroversion, and impulsivity. The results of this study suggested that the rate of discounting was equivalent for both high and low sensation seekers. However, extroverts and individuals who were highly impulsive delay discounted at a faster rate than introverts and low impulsive individuals, respectively. It should be noted that in a follow-up to this study Ostaszewski (1997) replicated these results. Ostaszewski (1996) hypothesizes two possible reasons that extroverts have a higher rate of discounting: (a) extroverts may have differences in time perception compared to introverts, and (b) extroverts may have a greater susceptibility to rewards (Eysenck & Gudjonsson, 1989). Extroverts typically view the passage of time more slowly than introverts do (Lynn, 1961; Wudel, 1979), and, therefore, extroverts would be expected to discount at a faster rate because the given amount of time would seem to be longer. In addition, the researchers posit that for extroverts an immediate reward may be a stronger incentive than it is for an introvert.

These results of discounting and introversion-extroversion should not be taken too strongly; there was only a small significant difference between the two groups when the delayed reward was of a larger sum ($1,000) and the difference has not shown to occur for smaller delayed rewards ($100). On the other hand, level of impulsivity has shown to be a decent predictor of delay discounting, however, it typically only accounts for, at most, 24% of the variance (Alessi & Petry, 2003; Hinson et al., 2003; Kirby, Petry & Bickel, 1999; Mitchell, 1999; Petry, 2002; Vuchinich & Simpson, 1998). Furthermore, in four studies (Bickel, Odum & Madden, 1999; Crean, de Wit & Richards, 2000; Reynolds, Richards, Horn & Karraker, 2004; Richards, Zhang, Mitchell & de Wit, 1999) no significant correlation was found between delay discounting and impulsivity. Other personality traits, such as sociability, may be a better predictor of delay discounting and will be a focus of the present study. Pilot research on sociability, as measured by the Socialization (So) scale of the California Psychological Inventory (CPI; Gough, 1987), and its relationship with delay discounting has shown that decreased sociability was associated with higher rates of discounting (Collins et al., 2005).

*Effects of Family History, Sociability and Cognitive Load on Delay Discounting*

Family history has been viewed as important to the understanding of substance abuse. Ehlers (1995) found that (FH+) individuals are two to four times as likely to develop alcohol dependence as individuals without a family history of alcoholism (FH-). Researchers have also demonstrated that children whose parents have other substance abuse symptoms or who have suffered from severe substance use disorders are more likely than controls to develop substance abuse problems of their own (Cloninger, Bohman & Sigvardssou, 1981; Cotton, 1979; Kapiro et al., 1987). In addition, Sher et al.

(1991) and Blum and Kozlowski (1990) found FH+ college students to score higher in impulsivity and risk taking measures than FH- peers. FH+ college students when compared to their FH- peers have also been found to show a lack of normal positive affect (Blum & Kozlowski, 1990). Though family history seems to be an important indicator of future substance use, recent findings (e.g., Collins et al., 2005; Werner, 1986) in the area of sociability has led researchers to question whether family history and sociability together predict future problem substance use better than family history alone.

Sociability, as measured by the So scale of the CPI, can be generically defined as an individual's compliance, or lack thereof, with societal norms. Gough (1994), with a more comprehensive definition, contended that the So scale serves as an indicator of the extent an individual has internalized prosocial values, systems of control, and other adaptive mechanisms necessary for norm-observing behavior.

The So Scale has shown to be predictive of rule abiding versus rule-breaking behavior. Moreover, a clinical range cut-off score of 30 has been established where groups with a mean above thirty appear to have no clinically significant problems with socialization, while those groups with a mean below 30 have at least some difficulty in socialization (Gough, 1994). It is important to point out that the So scale cut-off score appears to be quite reliable and valid. Out of 104 groups studied there have been no groups with low-socialization attributes with a mean above 30 on the So scale (Gough, 1994). It is also important to note that among less-socialized groups there seems to be an additive effect. For example, Forgac and Michaels (1982) found that a group of male exhibitionists with no prior record of criminal behavior had a So mean of 29.05, while a group of male exhibitionists with a prior history of crime had a So mean of 24.70. Mayer

and Ligman (1989) results demonstrated another example of this additive effect when they compared groups of college students who were non-users of marijuana, occasional users of marijuana, and those who were heavy users, with So means of 31.16, 26.90 and 22.08, respectively.

Other studies using the So scale, such as Searles and Alterman (1994), compared sons whose fathers had one or two symptoms of alcoholism to those whose fathers had three or more symptoms. The groups' respective So means were 27.42 and 25.07. Werner (1986) studied high school students in Hawaii whose fathers and/or mothers had serious problems with drinking alcohol when the student was between the ages of two and ten years old. Werner (1986) assessed and classified the students into two groups: one group comprised of those showing serious personal problems and the other group containing individuals who were relatively free of such personal problems. The So scale mean for the group of students with serious problems was 25.27, while for the group relatively free of such personal problems it was 29.93.

As a result of studies such as Searles and Alterman (1994) and Werner (1986), new questions have emerged. Does family history of substance abuse or sociability have an independent, additive, or interactional relationship with temporal choice making (i.e., delay discounting)? Does an individual's family history coupled with their degree of sociability provide a stronger association with temporal choice making and the possible development of future problems? If the latter question were supported, it would strengthen the position of a diathesis-stress model for explaining neurobehavioral function. That is, if an individual is family history positive for substance abuse, it may

also be necessary for them to be low in sociability to consider them to be truly at risk for future problems.

Collins et al. (2005) initiated exploratory research into whether sociability combined with family history is more strongly associated with decision making, as measured by delay discounting task, and substance use, than either family history or sociability alone. The results lend support for a main effect of sociability and not family history as being primarily associated with decision making. That is to say, individuals who were high in sociability, with or without a family history of substance abuse, discounted at a significantly lower rate than those individuals who were low in sociability. Also, there was no interaction between sociability and family history. When groups were combined across both FH and sociability, thus creating four groups (i.e., FH-/High So, FH-/Low So, FH+/High So, and FH+/Low So), Collins et al. (2005) found that FH+, low sociability individuals discounted delayed rewards significantly more than FH+, high sociability individuals. It is also noteworthy to mention that the Collins et al. (2005) study used a highly selected sample of individuals who did not suffer from substance use problems or other types of psychopathology. The present study will partly serve to replicate Collins et al. (2005) in an effort to see if the same results can be demonstrated with a less selective sample. Collins et al. (2005) suggests that since they used such a selective sample a relationship between FH and delay discounting may have been masked.

A recent study (Hinson et al., 2003) demonstrated that delay discounting scores are modifiable. Based on previous research suggesting a connection between working memory and impulse control problems (Finn, Justus, Mazas, & Steinmetz, 1999), the

researchers looked at the possibility that increased cognitive burden would be associated with an increase in rate of discounting delayed rewards. Specifically, they investigated "intrinsic" and "extrinsic" cognitive load manipulations of working memory and the relation to impulsive decision making. Impulsive decision making was measured by both a delay discounting measure and a standardized measure of impulsiveness (Barratt Impulsiveness Scale; BIS). An "extrinsic" cognitive load was created by having the participants try to retain, in memory, a string of numbers (e.g., 25341) during the delay discounting task and recall that information following completion of the discounting task (e.g., "What was the number to the right of 5?"). It has been demonstrated in a variety of studies that creating a cognitive load by requiring a participant to maintain a digit string in memory while performing another task does not merely occupy a verbal buffer but actually occupies attentional resources allocated by the executive component of working memory (Baddeley, Chincotta & Adlam, 2001; Toms et al., 1993). The "intrinsic" load was increased by increasing the number of options to be evaluated on the discounting task. Hinson et al. (2003) reported that an increase in "extrinisc" or "intrinsic" cognitive load leads to an increase in discounting of the delayed, hypothetical monetary reward. That is, by systematically increasing the amount of the cognitive load by either giving the participant more digits to remember or by giving them more choices on the discounting task, there was a direct increase in the rate of discounting the delayed monetary reward. Further, a strong relationship was found between standardized, self-report measures of impulsiveness (Barrett Impulsiveness Scale; BIS), executive dysfunction (Dysexecutive Questionnaire; DEX), and delay discounting. Therefore, the research suggests that both

"extrinsic" and "intrinsic" factors that increase cognitive burden, should be predictive of a more impulsive decision-making style (Hinson et al., 2003).

Along with the possibility that both sociability and family history of substance abuse, either separately or together, are more strongly associated with discounting rates, it will also be important to investigate if cognitive burden, as produced by a cognitive load, leaves low sociability individuals more susceptible to higher rates of discounting compared to individuals who are higher in sociability. That is, will low sociability individuals be more affected by cognitive burden and, therefore, even less likely to choose the delayed reward compared to high sociability individuals in the same condition?

# CHAPTER III

## PRESENT STUDY

The purpose of the present study was to investigate the relationship between sociability, family history of substance abuse, increased cognitive load and delay discounting. First, the association between family history of substance abuse, sociability and delay discounting was examined. Previous research indicates that individuals with a positive family history of a substance use disorder are at increased risk for substance use disorders of their own. Likewise, sociability, as measured by the So Scale, appears linked to increased risk with scores below 30 indicative of higher risk. Also, individuals with substance use disorders have greater delay discounting functions than non-substance use disorder controls. Furthermore, in a recent study, Collins et al. (2005) reported that for a non-substance use disorder sample, delay discounting was significantly greater for individuals with low So Scores, while family history did not differentiate participants delay discounting scores. Thus, it was expected in the present study that these findings would be replicated and extended to a larger sample. Delay discounting scores were predicted to show significant differences between high and low sociability groups independent of family history.

Second, it was investigated whether an increased cognitive burden through the use of a cognitive load would affect discounting rate. Previous studies demonstrate that by systematically increasing cognitive burden, researchers are able to directly increase discounting rates. Based on this research, it was expected that increased cognitive burden

would be associated with significantly higher discounting rates regardless of sociability and family history. Third, we examined whether groups who differ with regard to level of sociability were differentially affected by increased cognitive burden. It was predicted that the low So group's discounting rates would increase significantly more when compared to the high So group's discounting rates.

# CHAPTER IV

# METHOD

## *Participants*

Participants (N = 251; 188 females) were undergraduate students attending Oklahoma State University, ranging in age from 18 to 62 years (*M* = 20.4). The sample was 73% Caucasion, 9% Native American, 4% African American, 2% Asian American, 1% Hispanic American, 6% Other, and 5% did not report race or ethnicity. Participant's data were excluded from certain analyses involving family history comparisons if they did not meet the criteria necessary for FH+ or FH- for substance use disorders (see exclusion criteria below). All participants were enrolled in an undergraduate psychology course during their participation in the study, received extra-credit for participation, and were recruited through the Oklahoma State University Psychology Department's research subject pool, which is operated using Experimetrix internet-based software. Experimetrix requires that participants register for each experiment, thus stopping them from participating in the study more than once. Also, participants' IP addresses and month and date of birth were stored along with their data, allowing researchers to delete duplicated cases (if participants hit the "submit" button more than once).

## *Measures & Procedure*

The study was conducted on the internet. Participants connected to the study's URL address (http://fp.okstate.edu/collinslab/ted/) where they completed the measures at their convenience. Gender, age, ethnicity, and questions regarding history of

neurological issues and mental health treatment were assessed before completion of any of the following questionnaires occurred. The study was approved by the Oklahoma State University Institutional Review Board (see Appendix C).

*Family history of alcoholism and other drug problems*. Family history categorization was be determined using the Family History Research Diagnostic Criteria (FH-RDC; Andreasen, Endicott, Sitzer, & Winokur, 1977). The FH-RDC is a 109-item, self-report questionnaire and items are answered either "yes" or "no." The FH-RDC has a high degree of inter-rater reliability ($\alpha$ = .95) for reports of substance use disorders (Zimmerman, Coryell, Pfohl, & Stangl, 1988; Andreasen, Endicott, Sitzer, & Winokur, 1977). Participants were considered FH+ if biological father or biological mother were described as having/had a substance use problem, and considered FH- if none of the biological parents or grandparents were described as having/had substance use problems.

*Assessment of alcohol related problems*. Current alcohol consumption was assessed using the Brief Young Adult Alcohol Consequences Questionnaire (B-YAACQ; Kahler, Strong, & Read, 2005). The B-YAACQ is a 24-item measure in which the participant is presented questions in a dichotomous response format, covering: (1) social-interpersonal consequences, (2) impaired control, (3) self-perception, (4) self-care, (5) risk behaviors, (6) academic occupational consequences, (7) excessive drinking, and (8) physiological dependence. The B-YAACQ has shown very high internal consistency with a Cronbach's $\alpha$ of 0.83 (Kahler et al., 2005). In the present study, the $\alpha$ also indicated a very good internal consistency of 0.92. The measure also has strong convergent validity with other reliable and valid measures, such as the Rutgers Alcohol Problem Index (RAPI; White & Labouvie, 1989, $r$ = .78). The B-YAACQ is sensitive

for differing levels of severity and has been controlled for effects of gender (Kahler et al., 2005).

*Assessment of Sociability*. The Sociability scale of the California Psychological Inventory (So-CPI; Gough, 1987) was administered to assess participants' conformity to societal norms. In the CPI normative sample of 1,000 persons of each sex, the 46-item So scale had a correlation of 0.98 with the previous 54-item, 1957 version for each sex (Gough, 1994). Internal consistency was quite strong in the present study with a Cronbach's $\alpha$ of 0.78. Based on 69 studies, Gough (1994) indicates that for men scores of 32 and above are indicative of above average rectitude and conformity to societal norms, scores of 30-31 are indicative of ordinary normative compliance, and scores 29 and below are indicative of problems conforming to societal norms. Based on 41 studies, Gough (1994) indicated that for women scores of 33 and above are indicative of above average rectitude and conformity, scores of 32-30 are indicative of ordinary normative compliance, and scores of 29 and below are indicative of problems conforming to societal norms.

*Delay Discounting*. Delay discounting was assessed using the questionnaire developed by Kirby, Petry and Bickel (1999). This 27-item questionnaire presents hypothetical monetary choices between a smaller, more immediate choice and a larger delayed choice. The indifference points for each choice were created to represent 9 different discounting rates ($k$) ranging from 0.00016 to 0.25 with three items associated with each of the nine rates (Collins et al., 2005). For instance, one item is a choice between "$14 today" and "$25 in 19 days." Considering these factors, a $k$ of 0.041 is associated with an indifference (i.e., the participant finds each choice to be of equal

value) to these two choices. If the participant chooses the immediate reward of "$14 today," it will be assumed that he/she has a *k* greater than 0.041. However, if the participant chooses the delayed reward of "$25 in 19 days," it will be assumed that he/she has a *k* less than 0.041. The geometric mean between the rates where the participant chooses the immediate rewards and the rates where they choose the delayed rewards served as the individual participant's rate.

In addition to the two-choice delay discounting questionnaire, a three-choice delay discounting questionnaire was administered. This questionnaire has the same properties as the two-choice version and the same scoring criteria, with the exception of the third choice. For example, one item is a choice between "$14 today," "$25 in 19 days" or "$36 in 38 days." This three-choice item still has a *k* of 0.041 associated with the indifference point. As prescribed by the previous discounting research (e.g., Collins et al., 2005), for both the two and three-choice discounting questionnaires, participants were excluded if they always chose the immediate or delayed reward.

*Adaptation of the L and F scales from the MMPI-2*. In an attempt to exclude participants who were faking answers or who were randomly answering items, the present study included adapted items from the L and F scales of the MMPI-2 (J. Callahan, personal communication, August 8, 2005). This is a six-item questionnaire with three questions form each scale. An answer of "no" on any of the L scale items may indicate that the participant is trying to describe himself/herself in an unrealistic positive manner, while an answer of "yes" on any of the F scale items may indicate that the person is trying to describe himself/herself in an unrealistic negative manner. Participant's data was excluded from analyses if they endorsed either all three of the L

scale or F scale items. These scales were presented at the beginning and at the end of the study in order to help determine if participants were being consistent across the administration.

# CHAPTER V

# RESULTS

## *Preliminary Analyses*

*Correlation Matrixes*. See Table 1 for a comprehensive correlation matrix of interest to the present study. Regarding the L and F scales from the MMPI, no participant endorsed all three of the L or F scale items; therefore, no data was excluded from analyses because of these two scales. However, Pearson correlations indicated that the L scale scores were significantly associated with scores on the So scale [$r$ = .300, $p$(2-tailed) = .001] and the B-YAACQ [$r$ = -.176, $p$(2-tailed) = .017], indicating that participants who scored higher on sociability and participants who had fewer negative drinking behaviors were more likely to describe themselves in an unrealistically positive manner. F scale scores were also significantly correlated with So scores [$r$ = -.173, $p$(2-tailed) = .018] and the B-YAACQ [$r$ = .204, $p$(2-tailed) = .005] indicating that describing oneself in an unrealistically negative manner was significantly associated with lower sociability scores and more negative drinking behaviors. A Pearson correlation was conducted on the two L and F scales presented in the study in attempt to determine if participants were consistent across the administration. The correlations of the two measures was strongly associated [$r$ = .913, $p$(2-tailed) = .001] indicating that it should be assumed that a large majority of the participants answered consistently. Family history of substance use and So scores were also significantly correlated [$r$ = -.435, $p$(2-tailed) =

.001] with high So scores associated with participants who were FH-. Two-choice and three-choice delay discounting *k* scores were significantly correlated with B-YAACQ scores [$r$ = .184, $p$(2-tailed) = .012 and $r$ = .189, $p$(2-tailed) = .01, respectively]. Finally, So scores and B-YAACQ scores were significantly correlated [$r$ = -.379, $p$(2-tailed) = .001].

*Alcohol problems, FH, and Sociability*. Analyses of the B-YAACQ indicated that the current sample's mean ($M$ = 4.9) was much lower than the mean ($M$ = 8.6) that seen in the college sample used when designing the measure. A mean of 5 indicates, according to Kahler et al (2005), that the individuals in this group have a 79% chance of having done or said something embarrassing while drinking, a 23% chance of having done something impulsive when drinking that they regret, and only a 6% chance of reporting that drinking has harmed the quality of their work or schoolwork. Further, while Kahler et al. (2005) found it to be very rare (0.9% of the sample) for participants to not endorse any symptoms of consequences of alcohol use, in the present study, the modal number of symptoms endorsed was 0 (28.2% of the sample).

Additionally, analyses indicated that there was no significant difference between the FH- [$M$ = 4.6 (5.8)] or FH+ [$M$ = 5.0 (5.4)] group with regard to B-YAACQ scores [$t$(84) = .298, $p$(2-tailed) = .767]. However, there was a significant difference between the low sociability group [$M$ = 7.8 (6.5)] and the high sociability group [$M$ = 3.6 (4.4)], with the high sociability group having fewer problems with alcohol than the low sociability group [$t$(175) = 4.945, $p$(2-tailed) = .001, $d$ = .82]

*Determination of FH Status*. Based on criteria for determination of FH+ and FH- affiliation (i.e., FH+ if either biological parent have/had problems with substance use,

FH- if none of the biological parents or grandparents have/had problems with substance use), 165 participants were excluded from the preliminary and primary analyses involving FH. The FH+ group (n = 46) and FH- group (n = 40) significantly differed on sociability scores as measured by the CPI [$t(84) = 4.42$, $p$(2-tailed) = .001], whereby the FH- group [$M = 34.25$ (4.41)] had higher sociability scores than the FH+ group [$M = 29.02$ (6.24)], constituting a large effect size ($d = .92$).

*Primary Analyses*

*Hypothesis 1*. A hierarchical regression analysis was conducted to assess whether sociability would predict two-choice and three-choice discounting independent of family history of substance use. Two-choice delay discounting was significantly predicted by sociability [$B = -.001$ (.001), $t(82) = -2.531$, $p$(2-tailed) = .013], with sociability alone accounting for 7.1% of the variance in two-choice discounting but not by FH alone [$F(1,85) = .714$, $p = .40$, $R^2 = .008$]; however, it appeared that there was an additive effect with FH. Placing both sociability [$B = -.001$ (.001), $t(82) = -3.308$, $p$(2-tailed) = .001] and FH [$B = -.011$ (.005), $t(82) = -2.242$, $p$(2-tailed) = .028] into the model, resulted in 12.4% of the variance being accounted for in two-choice discounting, and this overall model was significant [$F(2,85) = 5.87$, $p = .004$]. The results from this sample indicate that sociability alone is a significant predictor, but that FH history also becomes a significant predictor in the context of sociability. That is, with the additional knowledge of a group's FH, a better prediction of their two-choice discounting behavior can be made. Therefore, the overall model predicts that groups high in sociability and FH+ will discount delayed rewards at a significantly lower rate than the low sociability group, FH- group. The beta weight for the interaction between sociability and FH with two-choice

discounting was not significant [$B$ = -.0001 (.001), $t$(82) = .489, $p$(2-tailed) = .626]. That is, sociability did not affect delay discounting (two-choice) differently across differing levels of FH. On the other hand, three-choice delay discounting was not significantly predicted by either sociability [$B$ = -.001 (.001), $t$(82) = -.535, $p$(2-tailed) = .594] or FH [$B$ = -.009 (.008), $t$(82) = -1.145, $p$(2-tailed) = .256]. The interaction between sociability and FH with three-choice discounting was also not significant [$B$ = .0001 (.001), $t$(82) = -.313, $p$(2-tailed) = .755]. The overall model was not significant, $F$(3,85) = .873, $p$ = .459, accounting for only 3.1% of the variability in the three-choice discounting.

In addition, correlation coefficients from both regression analyses were transformed using Fisher's $r$-to-$z$ transformation. Null hypothesis testing for the difference between the two correlations revealed that there was no significant difference between two-choice and three-choice discounting over sociability ($z$ = -1.127, $p$ > .05), FH ($z$ = -.747, $p$ > .05), or the interaction of sociability and FH ($z$ = .541, $p$ > .05). The results indicate that Hypothesis 1 was supported in that delay discounting scores showed significant differences between high and low sociability groups independent of FH, with high sociability groups discounting at a lower rate.

*Hypothesis 2*. A paired-samples $t$-test was conducted to assess whether increasing cognitive burden would result in significantly higher discounting rates in all participants, regardless of sociability or FH. The one-tailed analysis revealed that the cognitive burden significantly increased discounting rates [$t$(194) = -1.853, $p$ = .033]; however, the mean difference was small ($M_{diff}$ = -.00297, $SD_{diff}$ = .02237, $d$ = .13). The results indicate that Hypothesis 2 was supported in that increased cognitive burden was associated with significantly higher discounting rates.

*Hypothesis 3*. A 2 x 2 (Sociability x Delay Discounting) repeated measures ANOVA was performed to assess whether the low sociability group would increase their discounting rate significantly more compared to the high sociability group by increasing cognitive burden. The analyses revealed that the two groups failed to show an increase in discounting rates with the added cognitive burden [$F(1,184) = 1.599$, $p$(2-tailed) = .208] and did not significantly differentiate with the added cognitive load [$F(1,184) = .270$, $p$(2-tailed) = .604]. However, a test of between-subjects effects indicated that high sociability participants discounted delayed rewards (two-choice) at a much lower rate than low sociability participants [$t(184) = 2.159$, $p$(2-tailed) = .032]; however, the difference in means was moderate to small ($M_{diff} = .00964$, $d = .35$). The results indicate that Hypothesis 3 was not supported in that the low sociability group's discounting rates did not significantly increase more compared to high sociability discounting rates.

Because of interest in replicating the data of Collins et al. (2005), analyses were then conducted in order to categorize the participants into four groups (FH-/High So, FH-/Low So, FH+/High So, and FH+/Low So). Individuals were considered to be High So if their score was greater than or equal to 30 on the CPI-So scale and considered Low So if their score was less than 29.5 on the same scale, as recommended by Gough (1994). Please refer to Table 2 for means and standard deviations for each group with regard to age, and frequencies of gender and ethnicity. Independent samples t-tests and Chi-square analyses indicated no significant mean differences between the four groups on measures of age, gender, or ethnicity (all $p$'s > .05).

An ANOVA was not conducted due to the lack of power necessary to see an effect (FH-/Low So group n = 5). Consequently, four independent samples *t*-tests were

performed in order to determine the differences between the four groups. Mean delay discounting parameters (*k*) for both two-choice and three-choice measures are shown in Figures 1 and 3, however, analyses were only carried out on the two-choice measure in an effort to limit alpha inflation. The analyses revealed that the FH-/High So group discounted delayed rewards at a significantly higher rate than FH+/High So group [$t(45) = -2.208$, $p$(2-tailed) = .032], with a moderate difference between means ($M_{diff}$ = .00951, $d$ = .47). Furthermore, the FH+/Low So group also discounted at a significantly higher rate than the FH+/High So group [$t(26) = 3.065$, $p$(2-tailed) = .005], with a large difference between means ($M_{diff}$ = .01557, $d$ = .94). Finally, there was not a significant difference in discounting between the FH-/High So group and the FH+/Low So group [$t(55) = .966$, $p$(2-tailed) = .338] or between the FH-/Low So group and the FH+/High So group [$t(4) = 1.916$, $p$(2-tailed) = .125]. Figures 2 and 4 provide a graphical representation of the discounting rate for the four groups. Using *k* as a constant, the indifference point was computed across time as a function of value of the immediate choice represented as a percentage of the delay.

*Alcohol Problems and the Four Groups*. Analyses comparing the four groups (i.e., FH-/High So, FH-/Low So, FH+/High So, and FH+/Low So) on the B-YAACQ measure indicated that the FH-/Low So group [$M$ = 14.0 (6.1)] had significantly more drinking problems ($p < .01$) compared to all other groups [FH-/High So ($M$ = 4.3), FH+/Low So ($M$ = 5.7), FH+/High So ($M$ = 4.25)]. No other significant differences were found between the four groups. It should be noted again, however, that their were only five participants in the FH-/Low So group. All inferences made on behalf of this group should be made cautiously.

# CHAPTER VI

# DISCUSSION

The purpose of the present study was to investigate the relationship between sociability, family history of substance abuse, increased cognitive load and delay discounting. Further, the study sought to examine and replicate some of the general findings of Collins et al. (2005) study with a less selective sample.

First, the association between family history of substance abuse, sociability and delay discounting was examined. Specifically, it was predicted that high and low sociability groups would show significant differences in discounting delayed rewards independent of FH, similar to Collins et al. (2005). The analyses revealed that this hypothesis was supported in the two-choice delay discounting condition but not in the three-choice condition. These results are similar to the Collins et al. (2005) study that only used a two-choice condition. Specifically, those who were high in sociability discounted delayed rewards at a slower rate compared to those who were low in sociability. It is also important to note that there appears to be an additive effect, whereby sociability together with FH contributed to a significant portion of the variance of two-choice delay discounting, more so than sociability alone. The overall model predicts that groups high in sociability and FH+ will discount delayed rewards at a significantly lower rate than the low sociability group, FH- group. However, similar to Collins et al. (2005), FH alone was not a significant predictor of two-choice discounting. Possible reasons why having a family history of a substance use disorder is beneficial,

with regard to discounting, is uncertain at this time. It would be necessary for future studies to also see this relationship before adequate hypotheses could be made.

Additional analyses revealed that the current sample reported much lower problems associated with drinking than previous college based samples. This finding may be a result of participants attempting to present themselves in an unrealistically positive manner, or it may also be the result of Oklahoma State University being a "dry" campus and, therefore, not allowing students access to high quantities of alcohol. Still, differences were found between low and high sociability groups in regard to reported drinking problems. The low sociability group had significantly more drinking problems than the high sociability group. However, no significant differences were found between the two FH groups and drinking problems. These results lend even more support for previous study's suggestions (i.e., Collins et al., 2005; Werner, 1986) that sociability may be more strongly associated with future substance use problems than is FH.

Also, analyses revealed a significant positive correlation between discounting and current drinking behaviors and a negative correlation between sociability and discounting and between sociability and current drinking behavior. Thus, low sociability and impulsivity, as measured by a delay discounting task, may possibly be a risk factor for substance abuse. However, it still remains unclear whether substance use is caused by these two factors, or if these two factors are caused by increased substance use. In order to help clarify this question, it will be important for future studies to conduct prospective research in this area.

In the three-choice condition, it appears that an increase of cognitive burden resulted in both the high and low sociability groups discounting in a similar fashion. One

possible explanation for this lack of differentiation may be that, with an increase in cognitive burden, high and low sociability groups are similar in how they discount delayed rewards. However, it is more likely that the three-choice task that we employed for this study was not sensitive enough to capture the differences between the low and high sociability groups. In future research, it may be beneficial to investigate the effects of increased cognitive burden through the use of a longer and more sensitive three-choice delay discounting questionnaire. The questionnaire in the present study was only 27 items and did not differentiate between the participants choosing the first delayed reward or the second delayed reward over the immediate reward.

Second, it was investigated whether an increased cognitive burden through the use of a cognitive load would affect an individual's discounting rate regardless of FH or sociability status. Previous research conducted by Hinson et al. (2003) demonstrated that by systematically increasing cognitive burden, researchers were able to directly increase discounting rates. This finding was supported in the present study. However, the effect sizes were quite small compared to those seen in Hinson et al. (2003). Possible reasons for the difference between the results of this study and the previous research is that we used a 27-item, paper-and-pencil measure of delay discounting, while Hinson et al. (2003) used an 80-item, computer based measure of discounting. Again, as may be the case with the first hypothesis, Hinson et al.'s (2003) discounting measure may have been more sensitive to discriminating between the participant's discounting scores. Future research should investigate the three-choice task utilizing the 27-item, paper-and-pencil measure and Hinson et al.'s (2003) 80-item, computer-based task on the same sample in order to determine whether one task is more sensitive than the other.

Third, we examined whether individuals who differ with regard to level of sociability were differentially affected by increased cognitive burden. It was predicted that low So individual's discounting rates would increase significantly more when compared to high So individual's discounting rates. This hypothesis, however, was not supported. Though both groups discounting rates significantly increased with the added cognitive burden, analyses revealed that these increases were not differentially affected by the cognitive burden. Hinson et al. (2003) demonstrated that both high and low impulsive individuals were similarly affected by cognitive burden on a delay discounting task. This finding and the results of the present study may indicate that when an individual encounters a cognitive burden, regardless of sociability or impulsivity level, they increase their rate of discounting similarly, resulting in a lack of an interaction between the effects of increased cognitive burden and sociability (or impulsivity) level.

However, the data also revealed that low So individuals discounted at a significantly higher rate than the High So individuals on the two-choice delay discounting task. This replicates the findings of the Collins et al. (2005) study, indicating that low sociability may be a risk factor for a more impulsive decision-making style.

After grouping participants according to risk for substance use [following the method employed by Collins et al. (2005)], the data suggested that FH+ individuals had significantly lower sociability scores than did FH- individuals. This indicates that individuals who are FH+ may experience greater difficulty conforming to societal norms. Further analyses revealed that FH+/High So discounted delayed rewards at a significantly lower rate than both the FH+/Low So group and the FH-/High So group. This finding is similar to that found in previous research, whereby individuals who have/had a father or

mother with a substance use disorder, but at the same time are high in sociability seem to not be as impulsive or experience as many personal issues with drinking as individuals who are lower in sociability. It will be important for future research to look at other characteristics of this group (e.g., religiosity, views on substance use). It may also be beneficial to bring this group in for an interview and ask them questions about their FH and their perception of how/why they have been affected or not affected by its presence. Finally, analyses indicated that the FH-/Low sociability group had significantly more problems with alcohol compared to all other groups. Though speculation as to the characteristics of this group should be made cautiously (because of the small sample size), it is notable that this group's mean indicates that they are endorsing symptoms that are consistent with alcohol abuse and dependence. Kahler et al. (2005) suggests that individuals with a score of 15 have an 81% chance of having done something impulsive when drinking that they regret and a 49% chance of reporting that drinking has harmed the quality of their work or schoolwork. Further, signs of hazardous use and role impairment (e.g., driving while intoxicated) are likely, and there is a 63% chance that they would be experiencing trouble limiting their drinking.

*Strengths and Limitations*

The present study sought to replicate part of the findings in the Collins et al. (2005) study. The results of this study support the previous research in its finding that FH+ individuals appear to be lower in sociability than FH- individuals. It also replicated the finding that if an individual is FH+ and also high in sociability, it appears that they are less impulsive. This study, however, further adds to the current research by demonstrating that there appears to be an additive relationship between sociability and

FH, in predicting two-choice discounting scores, and that high sociability individuals are also less likely to take part in negative drinking behaviors. The Collins et al. (2005) study screened out for established substance use problems and other types of psychopathology, so this latter relationship was not evident in that study.

Several important limitations are acknowledged in the current study. First, the lack of a prospective design limits any causal inferences that can be made. Although an apparent relationship between sociability, delay discounting, and drinking patterns exist, inference about causation and direction cannot be reliably made. Therefore, future research may implement a prospective design that would track individuals who fell into one of the four categories of FH and sociability but who currently did not engage in problematic drinking. These students could then be followed throughout each year of college to reassess drinking behaviors.

Second, due to the relatively small sample size of the FH-/Low sociability group in the present study, it is possible that there was not enough power to determine a significant difference between this group and the other groups. Though there appears to be a very low incidence of this group, future research should include a larger sample to increase power and the probability that differences will be detected.

Finally, the two-choice and three-choice measures of discounting used in the present study are only one approach, of many, to understanding discounting. Although the paper-and-pencil version is much faster and appears to be well correlated with more time intensive approaches (Epstein et al., 2003), it is limited in the number of discounting parameters with which to differentiate participants (only 9 possible values of *k*). It is strongly encouraged that future research include two separate measures of delay

discounting, with one being the 27-item paper-and-pencil version and the other being more time intensive, such as the 80-item measure created by Reynolds et al. (2004).

*Conclusions*

In summary, the present study is a partial replication of Collins et al. (2005) and also an attempt to look at the potential effects of cognitive burden across sociability and FH. Sociability alone but not FH alone predicted two-choice discounting *k* values; however, there was an additive effect, whereby sociability together with FH accounted for significantly more variance than sociability alone. The overall additive model suggest that FH is only significant in the context of sociability, and that groups who are high in sociability and FH+ discount delayed rewards less than groups who are low in sociability and FH-. Furthermore, no interaction was found between FH and sociability. Additionally, increases in discounting rates were associated with increased cognitive burden, but this effect only occurred within and not between groups.

# REFERENCES


Ainslie, G., Haslam, N., Loewenstein, G., & Elster, J. (1992). Hyperbolic discounting. In *Choice over time.* (pp. 57-92): Russell Sage Foundation.

Alessi, S. M., & Petry, N. M. (2003). Pathological gambling severity is associated with impulsivity in a delay discounting procedure. *Behavioural Processes, 64*, 345-354.

Andreasen, N. C., Endicott, J., Spitzer, R. L., & Winokur, G. (1977). The family history method using diagnostic criteria: Reliability and validity. *Archives of General Psychiatry, 34*, 1229-1235.

Baddeley, A., Chincotta, D., & Adlam, A. (2001). Working memory and the control of action: Evidence from task switching. *Journal of Experimental Psychology: General, 130*, 641-657.

Baker, F., Johnson, M. W., & Bickel, W. K. (2003a). Decision-making in state lotteries: Half now or all of it later? *Psychonomic Bulletin & Review, 10*, 965-970.

Baker, F., Johnson, M. W., & Bickel, W. K. (2003b). Delay discounting in current and never-before cigarette smokers: Similarities and differences across commodity, sign, and magnitude. *Journal of Abnormal Psychology, 112*, 382-392.

Barkley, R. A., Edwards, G., Laneri, M., Fletcher, K., & Metevia, L. (2001). Executive functioning, temporal discounting, and sense of time in adolescents with attention deficit hyperactivity disorder (ADHD) and oppositional defiant disorder (ODD). *Journal of Abnormal Child Psychology, 29*, 541-556.

Benzion, U., Rapoport, A. & Yagil, J. (1989). Discount rates inferred from decisions: An experimental study. *Management Science*, 35, 270-284.

Bickel, W. K., & Madden, G. J. (1999). A comparison of measures of relative reinforcing efficacy and behavioral economics: Cigarettes and money in smokers. *Behavioural Pharmacology, 10*, 627-637.

Bickel, W. K., Odum, A. L., & Madden, G. J. (1999). Impulsivity and cigarette smoking: Delay discounting in current, never, and ex-smokers. *Psychopharmacology, 146*, 447-454.

Blum, K. & Kozlowski, G. P. (1990). Ethanol and neuromodulator interactions: A cascade model of reward. *Progress in Alcohol Research, 2,* 131-149.

Britt, D. M. (1996). *The development of a habits use questionnaire: Relationship of cigarette smoking, alcohol, caffeine, and chewing gum use in a college population*. Unpublished master's thesis, Oklahoma State University, Stillwater.

Britt, D. M., Collins, F. L., Jr., & Cohen, L. M. (1999). Cigarette smoking and chewing-gum use among college students. *Journal of Applied Biobehavioral Research, 4*, 85-90.

Cahalan, D., & Cisin, I. H. (1968). American drinking practices: Summary of findings from a national probability sample: II. Measurement of massed versus spaced drinking. *Quarterly Journal of Studies on Alcohol, 29*, 642-656.

Cairns, J. A. (1992). Health, wealth and time preference. *Project Appraisal*, 7, 31-40.

Chapman, G. B. (1996). Temporal discounting and utility for health and money. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 22*, 771-791.

Chapman, G. B., & Johnson, E. J. (1995). Preference reversals in monetary and life expectancy evaluations. *Organizational Behavior & Human Decision Processes, 62*, 300-317.

Cloninger, C. R., Bohman, M., & Sigvardsson, S. r. (1981). Inheritance of alcohol abuse: Cross-fostering analysis of adopted men. *Archives of General Psychiatry, 38*, 861-868.

Collins, F. L., Vincent, A. S., Sorraco, K. H., & Lovallo, W. R. (2005). *Delay Discounting, Sociability, and Family History for Substance Use*. Unpublished Manuscript, Oklahoma State University.

Cotton, N. S. (1979). The familial incidence of alcoholism: A review. *Journal of Studies on Alcohol, 40*, 89-116.

Crean, J. P., de Wit, H., & Richards, J. B. (2000). Reward discounting as a measure of impulsive behavior in a psychiatric outpatient population. *Experimental & Clinical Psychopharmacology, 8*, 155-162.

Du, W., Green, L., & Myerson, J. (2002). Cross-cultural comparisons of discounting delayed and probabilistic rewards. *Psychological Record, 52*, 479-492.

Epstein, L., Richards, J., Saad, F., Paluch, R.A., Roemmich, J., & Lerman, C. (2003). Comparison between two measures of delay discounting in smokers. *Experimental and Clinical Psychopharmacology, 11*, 131-138.

Ehlers, C. L. (1995). Stress, gender and alcoholism risk: Findings in human and animal models. Hunt, W. A. and Zakhari, S. Bethesda, MD, US Government Printing Office. Stress, gender and alcohol-seeking behavior. Research Monograph No. 29 (NIH publication No. 95-3893).

Eysenck, H., & Gudjonsson, G. (1989). *The causes and cures of criminality*: Plenum Press.

Fagerström, K.O. (1978). Measuring degree of physical dependence to tobacco smoking with reference to individualization of treatment. *Addictive Behaviors, 3*, 235-241.

Forgac, G. E., & Michaels, E. J. (1982). Personality characteristics of two types of male exhibitionists. *Journal of Abnormal Psychology, 91*, 287-293.

Gough, H. G. (1987). *The California Psychological Inventory, administrators guide*. Palo Alto, CA: Consulting Psychologists Press.

Gough, H. G. (1994). Theory, development, and interpretation of the CPI Socialization scale. *Psychological Reports, 75*, 651-700.

Green, L., Fisher, E. B., Perlow, S., & Sherman, L. (1981). Preference reversal and self control: Choice as a function of reward amount and delay. *Behaviour Analysis Letters, 1*, 43-51.

Green, L., Fristoe, N., & Myerson, J. (1994). Temporal discounting and preference reversals in choice between delayed outcomes. *Psychonomic Bulletin & Review, 1*, 383-389.

Green, L., Fry, A. F., & Myerson, J. (1994). Discounting of delayed rewards: A life-span comparison. *Psychological Science, 5*, 33-36.

Green, L., & Myerson, J. (2004). A Discounting Framework for Choice With Delayed and Probabilistic Rewards. *Psychological Bulletin, 130*, 769-792.

Green, L., Myerson, J., Holt, D. D., Slevin, J. R., & Estle, S. J. (2004). Discounting of delayed food rewards in pigeons and rats: Is there a magnitude effect? *Journal of the Experimental Analysis of Behavior, 81*, 39-50.

Green, L., Myerson, J., Lichtman, D., Rosen, S., & Fry, A. (1996). Temporal discounting in choice between delayed rewards: The role of age and income. *Psychology & Aging, 11*, 79-84.

Green, L., Myerson, J., & McFadden, E. (1997). Rate of temporal discounting decreases with amount of reward. *Memory & Cognition, 25*, 715-723.

Heatherton, T. F., Kozlowski, L. T., Frecker, R. C., & Fagerström, K.O. (1991). The Fagerström Test for Nicotine Dependence: A revision of the Fagerström Tolerance Questionnaire. *British Journal of Addiction, 86*, 1119-1127.

Hinson, J. M., Jameson, T. L., & Whitney, P. (2003). Impulsive decision making and working memory. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 29*, 298-306.

Jaroni, J. L., Wright, S. M., Lerman, C., & Epstein, L. H. (2004). Relationship between education and delay discounting in smokers. *Addictive Behaviors, 29*, 1171-1175.

Johnson, M. W., & Bickel, W. K. (2002). Within-subject comparison of real and hypothetical money rewards in delay discounting. *Journal of the Experimental Analysis of Behavior, 77*, 129-146.

Lynn, R. (1961). Introversion-extraversion differences in judgments of time. *Journal of Abnormal & Social Psychology, 63*, 457-458.

Kahler, C., Strong, D., Read, J. (2005). Toward efficient and comprehensive measurement of the alcohol problems continuum in college students: The Brief Young Adult Alcohol Consequences Questionnaire. *Alcoholism: Clinical and Experimental Research, 29*, 1180-1189.

Kapiro, J., Koshenvao, M., & Langinvainio, H. (1987). Genetic influences on use and abuse of alcohol: A study of 5, 638 adult Finnish twin brothers. *Alcoholism, 11*, 349-356.

Killen, J. D., Fortmann, S. P., Kraemer, H. C., & Varady, A. (1992). Who will relapse? Symptoms of nicotine dependence predict long-term relapse after smoking cessation. *Journal of Consulting & Clinical Psychology, 60*, 797-801.

Kirby, K. N. (1997). Bidding on the future: Evidence against normative discounting of delayed rewards. *Journal of Experimental Psychology: General, 126*, 54-70.

Kirby, K. N., & Herrnstein, R. J. (1995). Preference reversals due to myopic discounting of delayed reward. *Psychological Science, 6*, 83-89.

Kirby, K. N., & Marakovic, N. N. (1995). Modeling myopic decisions: Evidence for hyperbolic delay-discounting within subjects and amounts. *Organizational Behavior & Human Decision Processes, 64*, 22-30.

Kirby, K. N., Petry, N. M., & Bickel, W. K. (1999). Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls. *Journal of Experimental Psychology: General, 128*, 78-87.

Kirby, K. N., & Santiesteban, M. (2003). Concave utility, transaction costs, and risk in measuring discounting of delayed rewards. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 29*, 66-78.

Loewenstein, G. F. (1988). Frames of mind in intertemporal choice. *Management Science, 34*, 200-214.

Loewenstein, G., & Elster, J. (1992). *Choice over time*: Russell Sage Foundation.

MacKeigan, L. D., Larson, L. N., Draugalis, J. R., Bootman, J. L. & Burns, L. R. (1993). Time preference for health gains versus health losses. *Pharmacoeconomics, 3*, 374-386.

Madden, G. J., Bickel, W. K., & Jacobs, E. A. (1999). Discounting of delayed rewards in opioid-dependent outpatients: Exponential or hyperbolic discounting functions? *Experimental & Clinical Psychopharmacology, 7*, 284-293.

Madden, G. J., Petry, N. M., Badger, G. J., & Bickel, W. K. (1997). Impulsive and self-control choices in opioid-dependent patients and non-drug-using control patients: Drug and monetary rewards. *Experimental & Clinical Psychopharmacology, 5*, 256-262.

Mayer, J. E., & Ligman, J. D. (1989). Personality characteristics of adolescent marijuana users. *Adolescence, 24*, 965-976.

Mazur, J. E., Commons, M. L., & Mazur, J. E. (1987). An adjusting procedure for studying delayed. In *Effect of delay and of intervening events on reinforcement value.* (pp. 55-73): Lawrence Erlbaum Associates, Inc.

Mischel, W., Shoda, Y., & Rodriguez, M. L. (1989). Delay of gratification in children. *Science, 244*, 933-938.

Mitchell, S. H. (1999). Measures of impulsivity in cigarette smokers and nonsmokers. *Psychopharmacology, 146*, 455-464.

Mitchell, S. H. (2004). Effects of short-term nicotine deprivation on decision-making: Delay, uncertainty and effort discounting. *Nicotine & Tobacco Research, 6*, 819-828.

Myerson, J., & Green, L. (1995). Discounting of delayed rewards: Models of individual choice. *Journal of the Experimental Analysis of Behavior, 64*, 263-276.

Odum, A. L., Madden, G. J., Badger, G. J., & Bickel, W. K. (2000). Needle sharing in opioid-dependent outpatients: Psychological processes underlying risk. *Drug & Alcohol Dependence, 60*, 259-266.

Ostaszewski, P. (1996). The relation between temperament and rate of temporal discounting. *European Journal of Personality, 10*, 161-172.

Ostaszewski, P. (1997). Temperament and the discounting of delayed and probabilistic rewards: Conjoining European and American psychological traditions. *European Psychologist, 2*, 35-43.

Petry, N. M. (2001). Pathological gamblers, with and without substance abuse disorders, discount delayed rewards at high rates. *Journal of Abnormal Psychology, 110*, 482-487.

Petry, N. M. (2002). Discounting of delayed rewards in substance abusers: Relationship to antisocial personality disorder. *Psychopharmacology, 162*, 425-432.

Petry, N. M., & Casarella, T. (1999). Excessive discounting of delayed rewards in substance abusers with gambling problems. *Drug & Alcohol Dependence, 56*, 25-32.

Pinto, R. P., Abrams, D. B., Monti, P. M., & Jacobus, S. I. (1987). Nicotine dependence and likelihood of quitting smoking. *Addictive Behaviors, 12*, 371-374.

Rachlin, H., Raineri, A., & Cross, D. (1991). Subjective probability and delay. *Journal of the Experimental Analysis of Behavior, 55*, 233-244.

Raineri, A., & Rachlin, H. (1993). The effect of temporal constraints on the value of money and other commodities. *Journal of Behavioral Decision Making, 6*, 77-94.

Reynolds, B., Richards, J. B., Horn, K., & Karraker, K. (2004). Delay discounting and probability discounting as related to cigarette smoking status in adults. *Behavioural Processes, 65*, 35-42.

Richards, J. B., Zhang, L., Mitchell, S. H., & de Wit, H. (1999). Delay or probability discounting in a model of impulsive behavior: Effect of alcohol. *Journal of the Experimental Analysis of Behavior, 71*, 121-143.

Searles, J. S., Alterman, A. I., Babor, T. F., & Hesselbrock, V. M. (1994). Environmental differences in young men with and without a family history of alcoholism. In *Types of alcoholics: Evidence from clinical, experimental, and genetic research.* (pp. 147-156): New York Academy of Sciences.

Shelley, M. K. (1993). Outcome signs, question frames, and discount rates. *Management Science*, 39, 805-815.

Sher, K. J., Walitzer, K. S., Wood, P. K., & Brent, E. E. (1991). Characteristics of children of alcoholics: Putative risk factors, substance use and abuse, and psychopathology. *Journal of Abnormal Psychology, 100*, 427-448.

Thaler, R. (1981). Some empirical evidence on dynamic inconsistency. *Economic Letters, 8*, 201-207.

Toms, M., Morris, N., & Ward, D. (1993). Working memory and conditional reasoning. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology, 46*, 679-699.

Vuchinich, R. E., & Simpson, C. A. (1998). Hyperbolic temporal discounting in social drinkers and problem drinkers. *Experimental & Clinical Psychopharmacology, 6*, 292-305.

Werner, E. E. (1986). Resilient offspring of alcoholics: A longitudinal study from birth to age 18. *Journal of Studies on Alcohol, 47*, 34-40.

Wudel, P. (1979). Time estimation and personality dimensions. *Perceptual and Motor Skills, 48*, 1320-1320.

Zimmerman, M., Coryell, W., Pfohl, B., & Stangl, D. (1988). The reliability of the family history method for psychiatric diagnoses. *Archives of General Psychiatry, 45*, 320-322.

# APPENDIX A

Tables

*Table 1*. Correlation matrix of L and F scales, discounting, sociability, family history and current drinking practices.

| | L scale | F scale | *k* 2-choice | *k* 3-choice | CPI | FH | BYAACQ |
|---|---|---|---|---|---|---|---|
| L scale | 1 | -.181* | -.126 | -.108 | .300** | -.161 | -.176* |
| F scale | -.181* | 1 | .071 | .058 | -.173* | -.144 | .204** |
| *k* 2-choice | -.126 | .071 | 1 | .746** | -.155* | -.072 | .184* |
| *k* 3-choice | -.108 | .058 | .746** | 1 | -.122 | -.076 | .189* |
| CPI | .300** | -.173* | -.155* | -.122 | 1 | -.435** | -.379** |
| FH- | -.161 | -.144 | -.072 | -.076 | .435** | 1 | .032 |
| BYAACQ | -.176* | .204** | .184* | .189* | -.379** | .032 | 1 |

Note: * Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). L scale = faking good; F scale = faking bad; *k* 2-choice = 2-choice discounting rate; *k* 3-choice = 3-choice discounting rate; CPI = California Psychological Inventory; FH- = no family history of problem substance use; BYAACQ = Brief Young Adult Alcohol Consequences Questionnaire.

*Table 2*. Demographics of the Four Sociability x Family History Groups

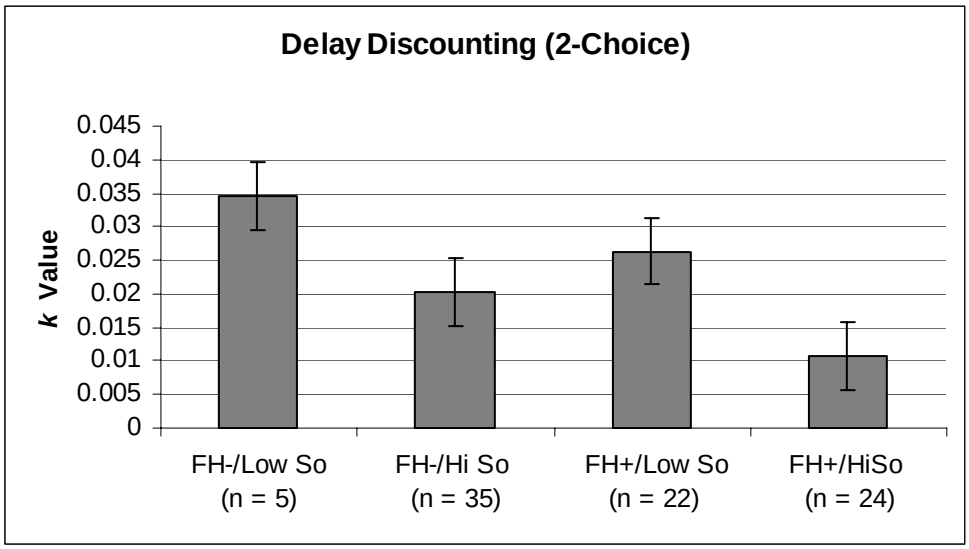
| | FH-/Low So | FH-/High So | FH+/Low So | FH+/High So |
|---|---|---|---|---|
| Men (%) | 40 | 26 | 19 | 17 |
| Women (%) | 60 | 74 | 81 | 83 |
| Age (years) | 19.2 (1.3) | 20.0 (3.9) | 22.7 (6.9) | 20.9 (3.8) |
| Caucasion (%) | 100 | 86 | 68 | 75 |
| African American (%) | 0 | 0 | 14 | 0 |
| Native American (%) | 0 | 7 | 18 | 17 |
| Other (%) | 0 | 7 | 0 | 8 |
| N | 5 | 35 | 22 | 24 |

Note: FH-/High So = High Sociability/Negative Family History; FH+/High So = High Sociability/Positive Family History; FH-/Low So = Low Sociability/Negative Family History; FH+/Low So = Low Sociability/Positive Family History.

# APPENDIX B

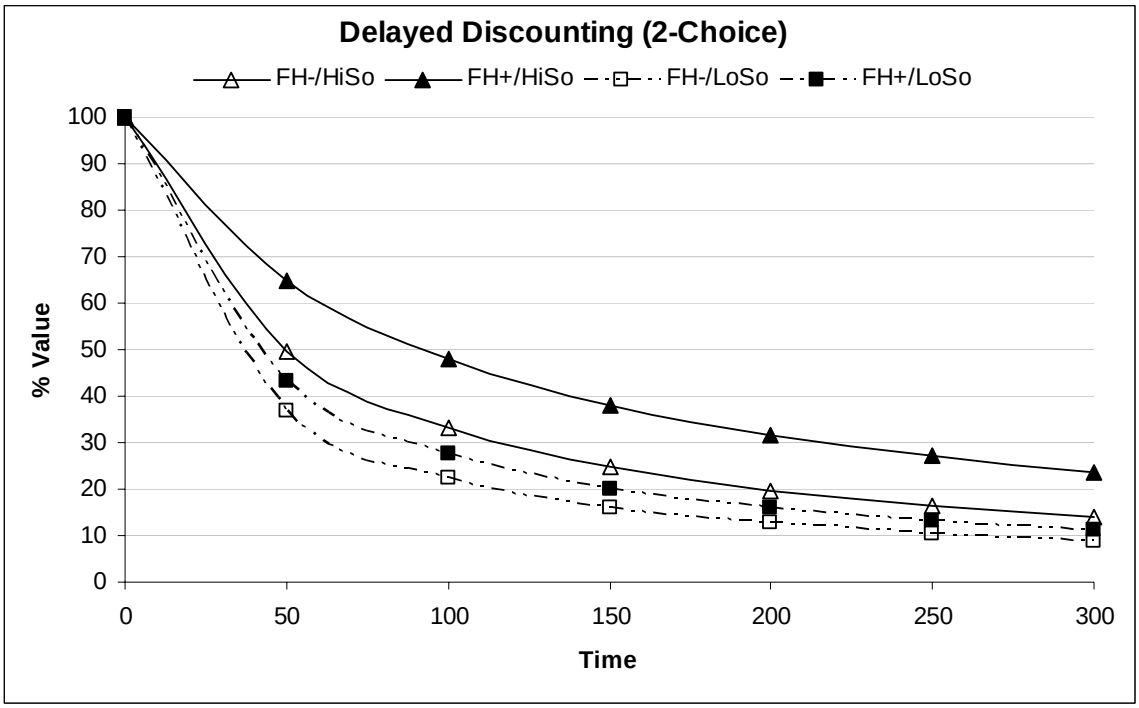
Figures

*Figure 1*. Mean *k*-value for Groups Categorized by Sociability and Family History on a Two-choice Delay Discounting Task.



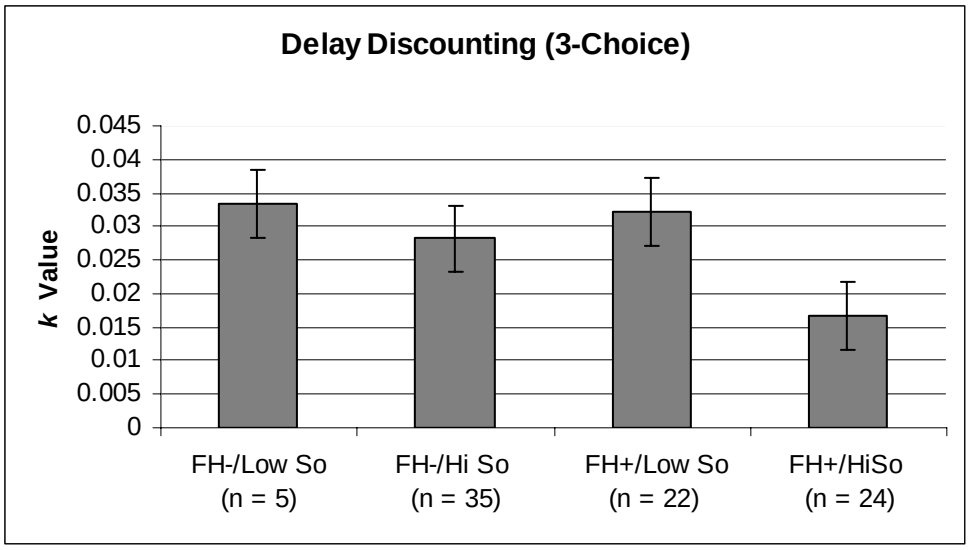

Note: FH-/Hi So = High Sociability/Negative Family History; FH+/Hi So = High Sociability/Positive Family History; FH-/Low So = Low Sociability/Negative Family History; FH+/Low So = Low Sociability/Positive Family History.

*Figure 2*. Percent Value of the Delayed Choice over Time (Two-choice delay discounting)



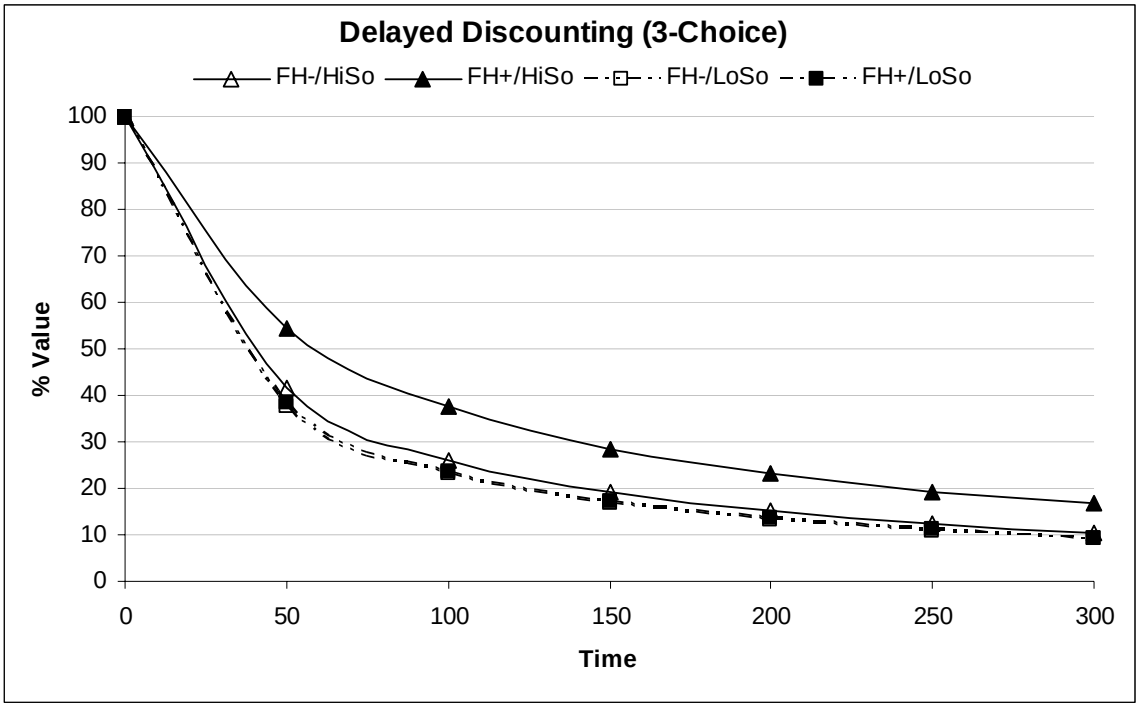

Note: FH-/HiSo = High Sociability/Negative Family History; FH+/HiSo = High Sociability/Positive Family History; FH-/LoSo = Low Sociability/Negative Family History; FH+/LoSo = Low Sociability/Positive Family History.

*Figure 3*. Mean *k*-value for Groups Categorized by Sociability and Family History on a Three-choice Delay Discounting Task.




Note: FH-/HiSo = High Sociability/Negative Family History; FH+/HiSo = High Sociability/Positive Family History; FH-/LoSo = Low Sociability/Negative Family History; FH+/LoSo = Low Sociability/Positive Family History.

*Figure 4*. Percent Value of the Delayed Choice over Time (Three-choice delay discounting)




Note: FH-/HiSo = High Sociability/Negative Family History; FH+/HiSo = High Sociability/Positive Family History; FH-/LoSo = Low Sociability/Negative Family History; FH+/LoSo = Low Sociability/Positive Family History.

# APPENDIX C

IRB Form

## Oklahoma State University Institutional Review Board

| | |
|---|---|
| Date: | Friday, October 14, 2005 |
| IRB Application No | AS0613 |
| Proposal Title: | The Effects of Increased Cognitive Load, Sociability and Family History of Substance Use on Delay Discounting |
| Reviewed and Processed as: | Expedited |

**Status Recommended by Reviewer(s): Approved Protocol Expires: 10/3/2006**

Principal Investigator(s

Theodore L. Wagener
215 N. Murray
Stillwater, OK 74078

Frank L Collins
215 N Murray
Stillwater, OK 74078

---

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

[X] The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 415 Whitehurst (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Sue C Jacobs

Sue C. Jacobs, Chair
Institutional Review Board

VITA

Theodore Lee Wagener

Candidate for the Degree of

Master of Science

Thesis: THE EFFECTS OF INCREASED COGNNITIVE LOAD, SOCIABILITY AND FAMILY HISTORY OF SUBSTANCE USE ON DELAY DISCOUNTING

Major Field: Psychology

Biographical

Education: Graduated *Magna cum laude* with a Bachelor of Arts in Psychology from the College of Wooster, Wooster, Ohio in May 2002. Received the degree of Master of Science from Oklahoma State University, Stillwater, Oklahoma in December 2005.

Experience: Completed a pre-doctoral practicum in pediatric psychology at the Cleveland Clinic Foundation, Cleveland, Ohio in the summer of 2001.

Professional Memberships: Association for the Advancement of Behavior Therapy and the American Psychological Association.

Name: Theodore Lee Wagener Date of Degree: December, 2005

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: THE EFFECTS OF INCREASED COGNITIVE LOAD, SOCIABILITY AND FAMILY HISTORY OF SUBSTANCE USE ON DELAY DISCOUNTING

Pages in Study: 59 Candidate for the Degree of Master of Science

Major Field: Psychology

Findings and Conclusions:

The present study is a partial replication of Collins et al. (2005) and also an attempt to look at the potential effects of cognitive burden across sociability and FH. Sociability alone but not FH alone predicted two-choice discounting *k* values; however, there was an additive effect, whereby sociability together with FH accounted for significantly more variance than sociability alone. The overall additive model suggest that FH is only significant in the context of sociability, and that groups who are high in sociability and FH+ discount delayed rewards less than groups who are low in sociability and FH-. Furthermore, no interaction was found between FH and sociability. Additionally, increases in discounting rates were associated with increased cognitive burden, but this effect only occurred within and not between groups.

ADVISER'S APPROVAL: Frank L. Collins, PhD